Reducing Grid Connected Load with Solar Energy

Henry M. Healey, P.E.

Merritt Island, Florida

www.flaenergy.com

As Blackouts Threaten

Turning off the Juice is Good

but

Turning on the Sun is Better

How can Solar actually reduce load?

We have problems at the mega-Watt level and Solar provides Watts!

How can Solar really help?

Why Consider Solar?

o **It's not interruptible!**

- ➢ Blackouts don't phase it
- ➢ It's reliable-the sun ***will*** come up tomorrow

o **It's inflation proof!**

- ➢ It's essentially free once you pay for collecting it

o **It will yield multiple dividends!**

- ➢ Economic & Environmental

Ok, let's get real!
Solar has a poor track record!

We have had poorly performing or inoperative systems removed from our buildings.

o **So have I,** but I've returned such systems to service quite easily and they are still working!

o While there have been problems in the past, the technology, equipment, certification processes and the construction infrastructure (design, construction and the commissioning process) in place today helps ensure successful solar installations.

Ok Then,
Lets Talk About Solar

To Reduce Load

o **Integrate Solar, Passive and Active Solar Solutions, Energy Conservation, Energy Efficiency and Energy Management into all New Building Designs**
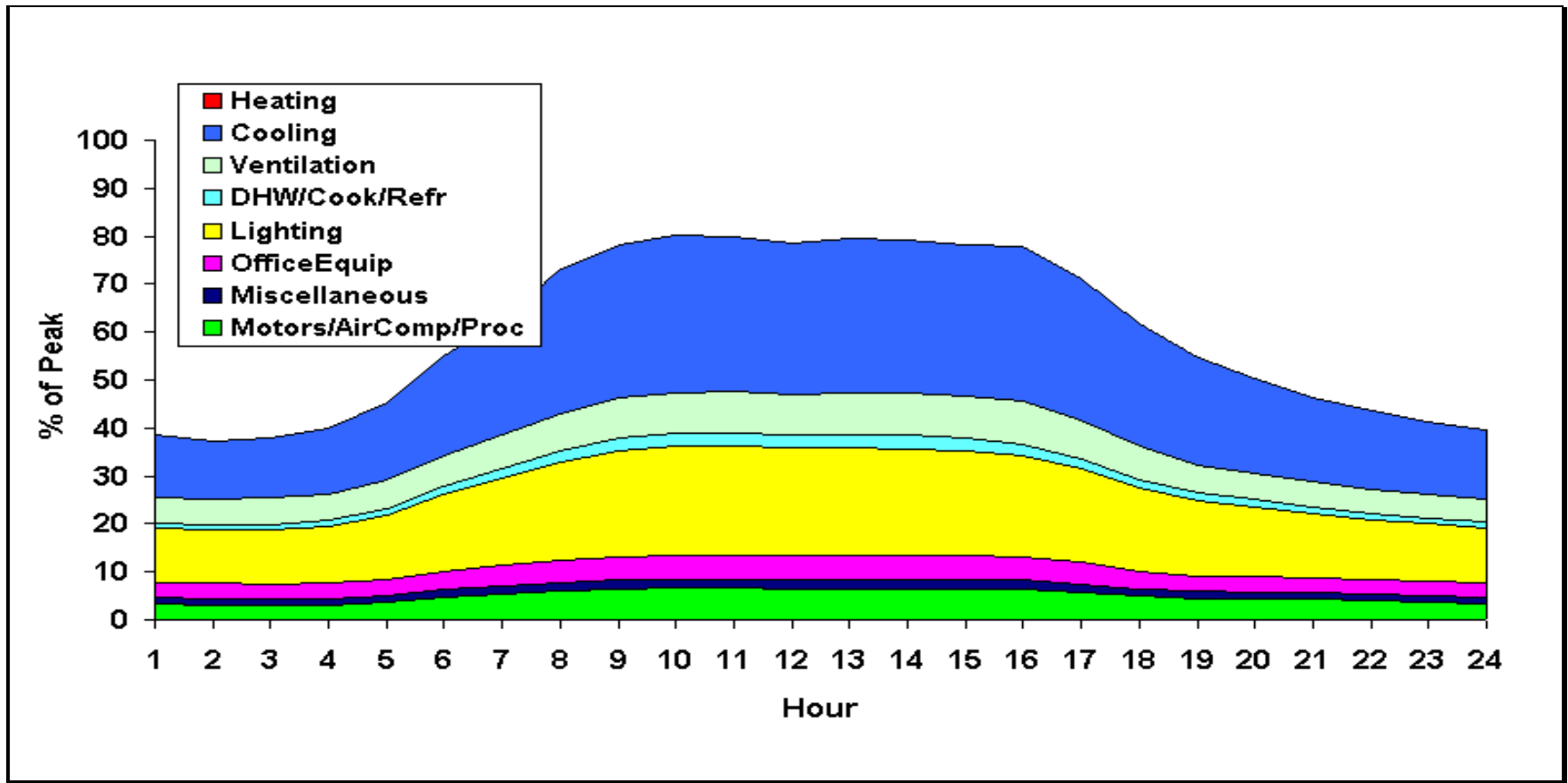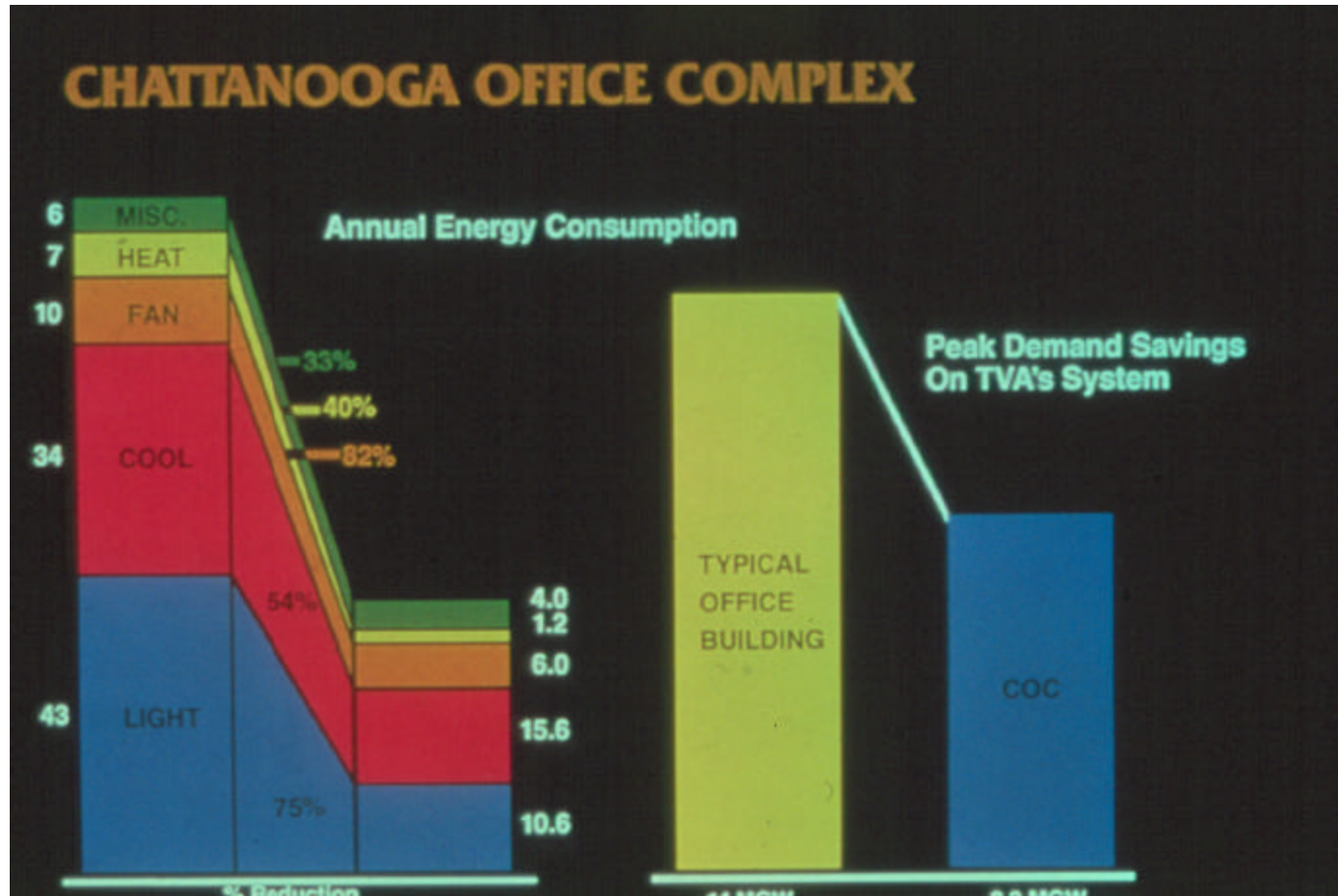

Lakeland Zero Energy Home

NREL Thermal Test Facility

Zion National Park Visitor Center

Office Building Load Profile

Solar Design Solutions

Buildings that combine energy efficiency and solar energy technologies to achieve a Zero Net Power Demand

It is being done cost effectively!
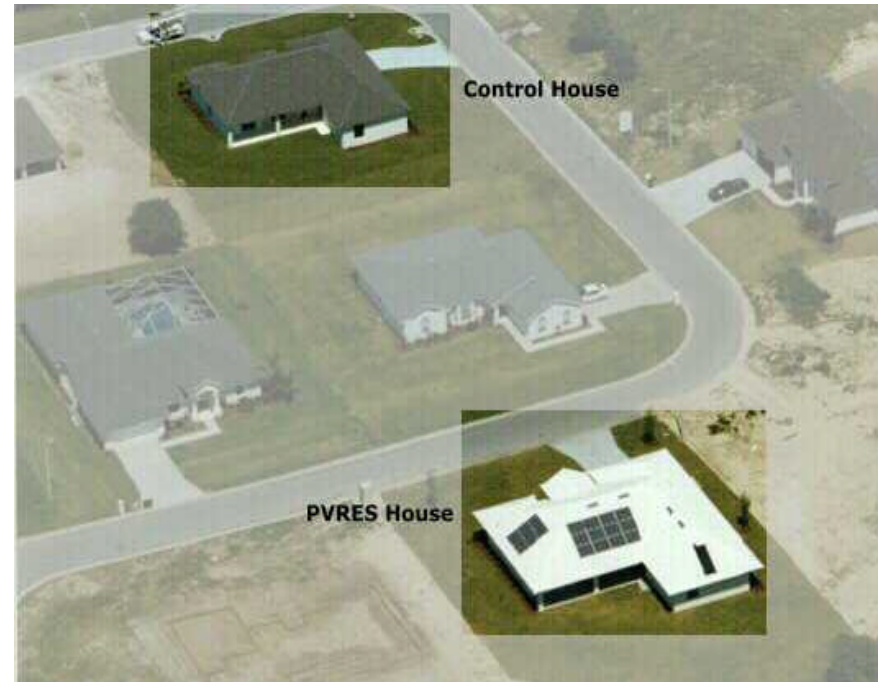
Aren't we "supposed" to use Life Cycle Costing-Do we?

Zero Energy Home
Lakeland, Florida

Features 4 kW PV System, Solar DHW, 3' Overhangs, Spectrally selective glazing, white tile roof, high efficiency appliances, exterior wall insulation…etc.

Side By Side Comparison Conventional Control house to PVRES

Control House

PVRES House

Contact www.fsec.ucf.edu

o Should be the goal for all new buildings

o Integrate passive and active solar (**energy production**) along with energy efficiency into new projects

o Life cycle costing and projected utility costs of alternatives must be a part of all design reviews!

o **Peak loads will be reduced!**

o Cost estimates are a part of all building projects

o Cost estimates for utilities are sometimes required (they <u>always</u> should be)

o Energy efficient design changes are often put off because projects are "over budget" without evaluating life cycle cost impact

o Building Budgets should be based on Total Cost

  ➢ Building operating (energy) cost is a real budget item

  ➢ Funding for a new building should not be approved unless it's operating cost is factored into the budget

o Life cycle cost of buildings needs to be the budget that is the basis of decisions in design reviews.

  ➢ Then Solar and other Energy efficiency design solutions can be included in projects at no cost increase

Typical Energy Efficient Buildings Include:

o Building orientation

o Daylighting

o Passive design solutions

  ➢ Spectrally selective glazing

  ➢ Overhangs

  ➢ Light color roofs

o High efficiency equipment

o Solar Energy Systems

  ➢ Building Integrated Photovoltaics

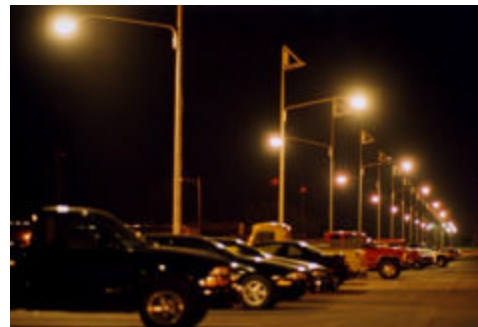 ➢ Water Heating

Passive Solar
Daylighting Savings
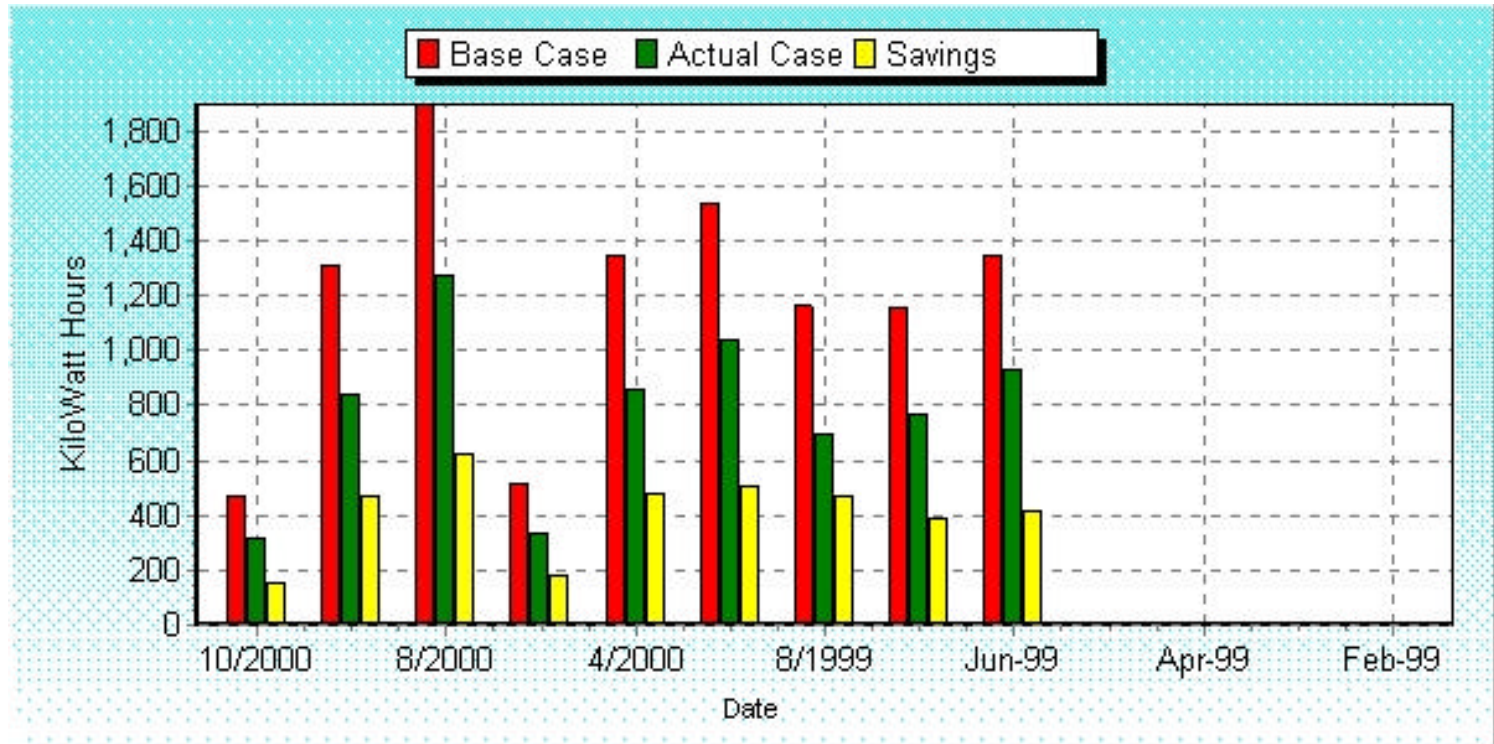
NREL Thermal Test Facility

Applying solar to existing buildings will also reduce load.

Solar Designs
for Existing Buildings
Start With an Energy Audit

o Load evaluation

o Energy conservation

o Integration of Solar

o Energy management

When you go solar you often start with a significantly smaller total load

How can Solar Energy be Used in Existing Facilities

- o Providing electric power
    - ➢ On-Site
        - ▫ Stand-Alone
        - ▫ Utility Interactive
    - ➢ Distributed Generation
- o Water and air heating
- o Lighting
- o Cooling, Ventilation and Process Applications

Solar Electric Systems

o Photovoltaics, Wind, Biomas or Hydro

o Applications

  ➢ Remote or Stand Alone

  ➢ Grid Connected
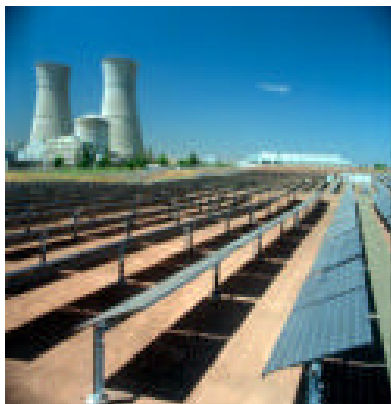
  ➢ Distributed Generation

Photovoltaic Power Plants

Photovoltaic Applications
Grid Connected

2-MW Single Axis Tracking

PV System
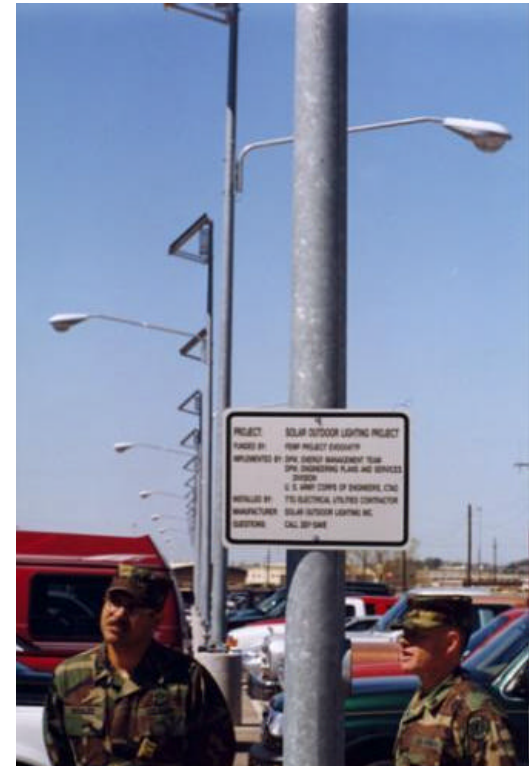

3.6 kW PV System on home

285 Wp Fixed Tilt PV System @

Provides electric power where it is required.

o **Applications include:**

➢ **Communications**

➢ **Security systems**

➢ **Lighting**

➢ **Ventilation**

➢ **Water Pumping**

➢ **Gate Operation**

➢ **Other**

For Safety or Security

Lighting

Transit shelters

Parking lot lighting

Daylighting

Power for buildings on islands or other remote sites

Wind Energy Systems

Can be grid connected or Stand Alone
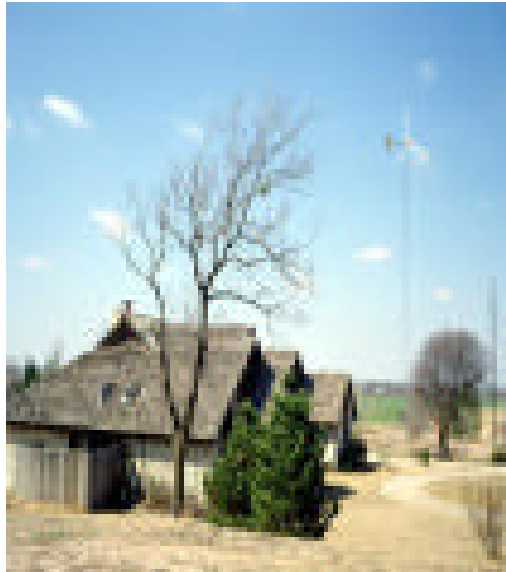
o Water or Air Heating for:

  ➢ Domestic Hot Water

  ➢ Pools & Spa's

  ➢ Space

  ➢ Process

    • Industrial

    • Agricultural

o **WATER HEATING**

- ➢ **Single and Multi-Family**
- ➢ **Hotel**
- ➢ **Light Commercial**
- ➢ **Swimming Pool & Spa heating**
- ➢ **Industrial Process Heat**
- ➢ **Agricultural**
- ➢ **Water purification/distillation**

High Temperature

Mid Temperature

Low Temperature

o **Service Hot Water**

o **Laundry (*Hotel or Commercial*)**

o **Restaurant - *Big or small***

o **Pool/Spa Heating**

o **Industrial Process Heat**

o **Space Conditioning**

   ➢ **Heat or Cool a building**

o **SPACE CONDITIONING**

- ➢ **Absorption Air-Conditioning**
- ➢ **De-humidification**
- ➢ **Building or space heating**
- ➢ **Green-house heating**

Commercial Facilities
Requiring Heat Energy

o **Hospitals and clinics**

o **Nursing and personal care facilities**

o **Photo processing**

o **Car washes**

o **Agricultural**

  ➢ **Crop drying**

  ➢ **Greenhouses**

o **Aqua-culture**

Food Processing Applications

o **Malt beverage manufacturing**

o **Cane sugar refining**

o **Prepared feed for animals facilities**

o **Frozen fruits, fruit juices, vegetables, soup mixes facilities**

o **Canned fruits, vegetables, preserves, jams**

o **Poultry and egg processing**

o **Meat packing facilities**

Other Applications

o **Commercial and public laundries**

o **Food preparation - Airport kitchens**

o **Fresh and frozen packaged fish and seafood**

o **Bottled and canned soft drinks**

Service Water Heating

Solar water heating systems for service hot water is simple, cost effective and reliable

Application Strategy

o **<u>Replace</u> or <u>pre-heat</u> conventional hot water heater or boiler**

o **Simple: Active or Passive system designs**

o **Low maintenance**

o **Easy to install**

Solar for Heating Swimming Pools

Solar PV and Pool Heating at the Olympics in Atlanta

Process Water Heating

for Building Heating & Washdown

Site built system heats 113,500 l/day (30,000 gpd)

Water heating - Distilleries

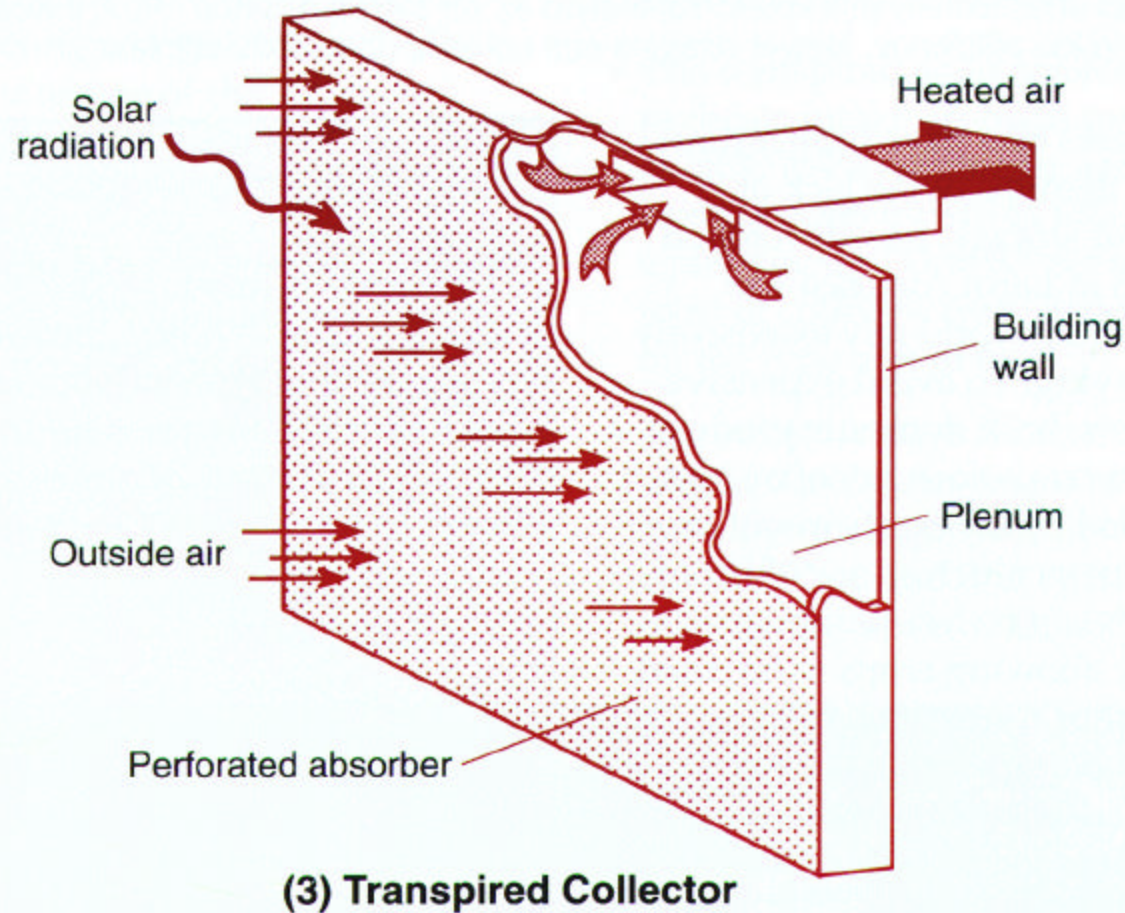# Air Heating System
Transpired Collector Wall

Transpired collector

Solar radiation

Heated air

Building wall

Plenum

Outside air

Perforated absorber

(3) Transpired Collector

Heats air on surface outside of metal wall

Air Heating Collector

- Heats the air as it is drawn through the collector
- Transfers the hot air into the building for heat and ventilation

Solar Crop Drying

- **Increasing the temperature of the air will lower the ability of the air to hold moisture.**

- **Moving dryer air across a material with a higher moisture content will effectively allow the wet material to give off or shed moisture.**

- **Heat will cause vapor and vapor must be vented to create drying.**

Other Solar Thermal Applications

o Solar Distillation

o Desiccant Dehumidification

o Hazardous Waste Reduction

o Crop Drying

Other Solar Technologies that are often cost effective

(but not fully discussed in this presentation)

o **Passive Solutions**

o **Biomass**

o **Solar Cooling**

o **Geothermal Systems**

o **Waste Reduction**

Aircraft Hanger Daylighting Retrofit, Wheeler Army Airfield, HI

A Few Items to Consider
When Investigating Solar Feasibility

o Requirements for Success

o Existing cost of energy

o Cost of solar energy systems

o Procurement options

o Where to get information

Successful
Solar Designs

o Conservation first

o Verify load and solar resource

o Appropriate design solution

o Performance guarantee

o Visual performance indicators

o Require O&M manual

o Acceptance test

Commercial Solar WH Systems

o Custom designs often required

o Few packaged, pre-plumbed systems

o Structural design required

o Flow balancing required

o Fail-safe freeze protection

o Look good and operate over its lifetime

Comparative
Energy Costs

- o **Cost of Energy: $/MBTU**

- o **$/MBTU=E$*(cnv fctr)/efficiency**

- o **Where**
  - ➢ **1kWh = 3,413 Btu**
  - ➢ **1 Therm = 100,000 Btu**
  - ➢ **1 Gal Oil= 138,690 Btu**
  - ➢ **1 MBTU = 1,000,000 Btu**

o **Electricity @ $ 0.10 / kwh : $ 29.33 / MBTU**

o **LPG @ $ 1.00 / Gallon: $ 14.95 / MBTU**

o **Natural Gas @ $ .050 / Therm: $ 7.14 / MBTU**

o **Fuel Oil @ $ 1.00 Gallon: $ 10.29 / MBTU**

Cost of Solar Energy

o **Solar LC Cost/ Delivered Energy**

$/Energy Unit (MBTU-kWh)

Where:

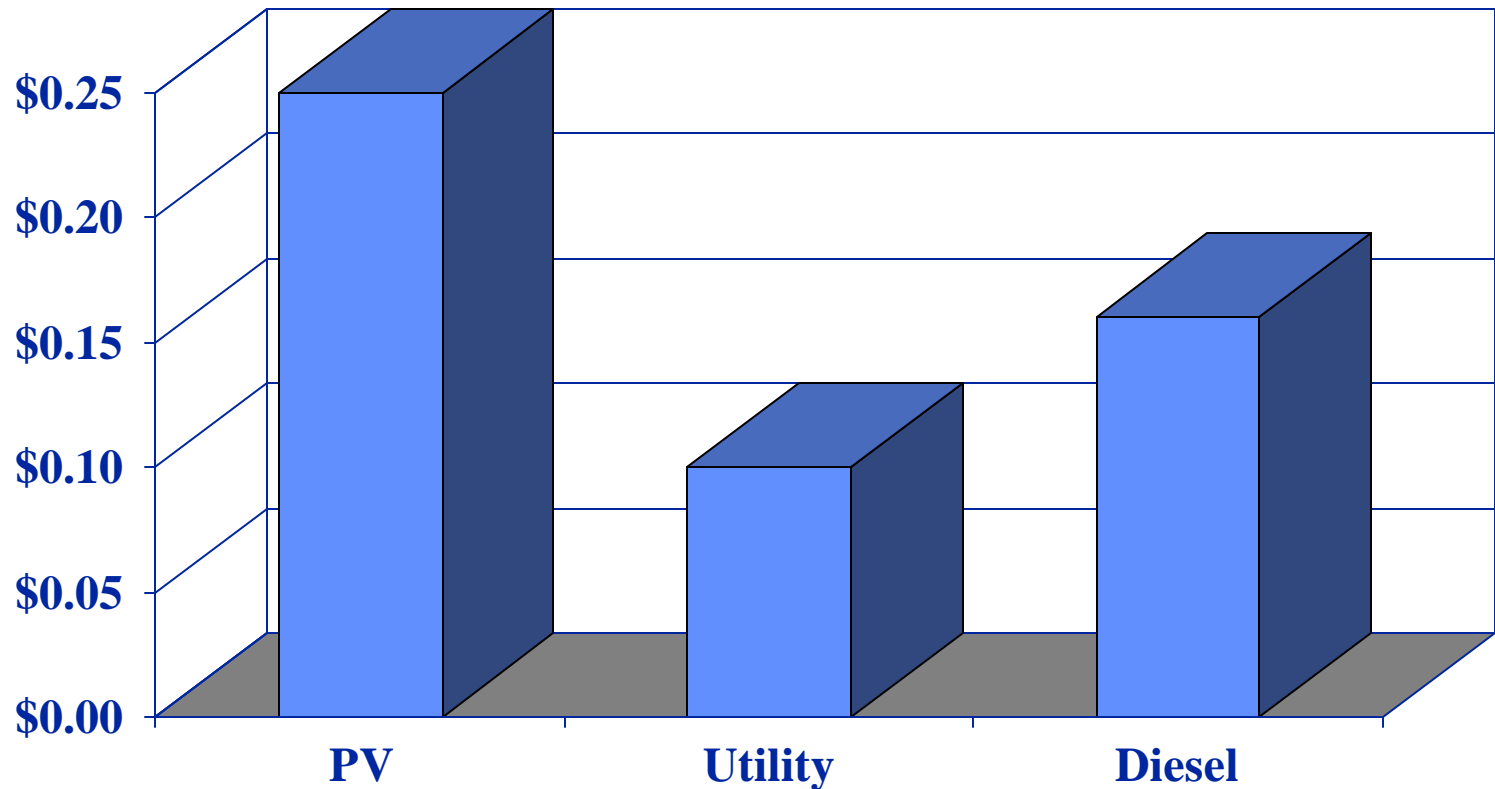**Solar Cost = Installed Cost + Operations and Maintenance Costs**

Delivered Energy = Annual Energy * System Life (20 yrs)

Commercial Solar Systems
Life Cycle Basis

o **Water Heating Effective Cost: Florida**

   @**$ 50** / SF: $ **12.50 / MBTU**

   @**$ 75** / SF : $ **18.50 / MBTU**

o **PV System Effective Cost: Florida**

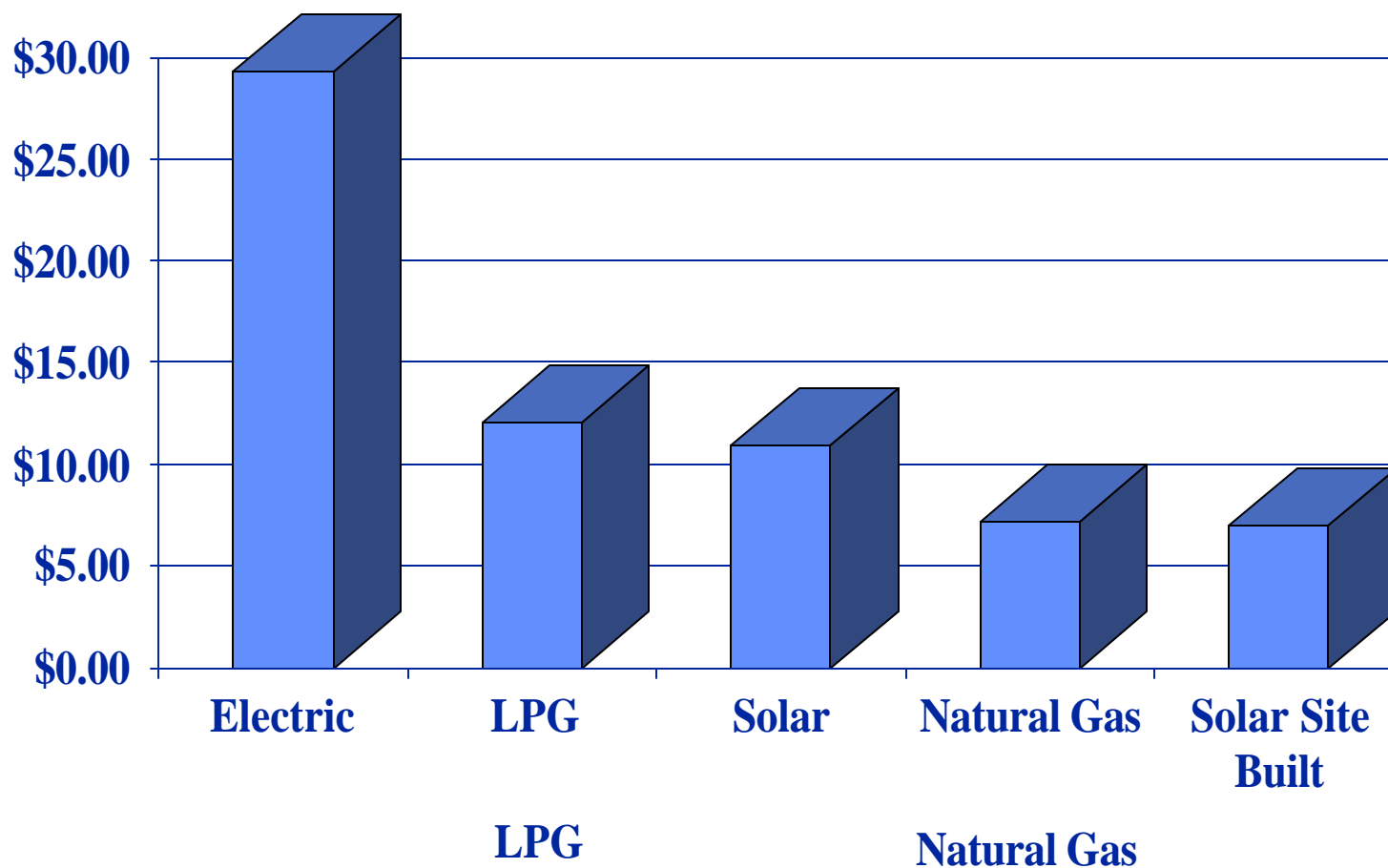   @ **$ 8/Wp: $ 0.25/kW**

   @ **$15/Wp: $ 0.50/kW**

Electric Power Costs

Water Heating Costs
Dollars Per Million Btu's

Procurement Options

o **Invitation for Bid (IFB)**

➤ commercially available off the shelf

o **Requests for Proposals (RFP)**

➤ unique or specialized system

requiring expertise or development

o **Performance Contracting** (ESPC-UESC)

o **GSA Schedule**

Solar Related Web "www" Sites

- o eren.doe.gov/femp
- o nrel.gov
- o sandia.gov
- o seia.org
- o fsec.ucf.edu
- o ashrae.org
- o retscreen.gc.ca

Henry M. Healey, P. E.

www.flaenergy.com

email:

healey@flaenergy.com